Flow Standards for Natural Gas

The increasing cost of natural gas, together with projected increases in consumption and imports (U.S. Energy Information Administration) are motivating improved measurement of this valuable commodity in pipelines. Presently, custody transfer of natural gas uses flow meters (e.g., turbine meters, ultrasonic flow meters) that are not directly traceable to SI units through NIST and are much too large to be calibrated on the NIST site. The uncertainty of the calibrations provided by private flow laboratories is approximately 0.5 %. The cost associated with flow uncertainties of this magnitude is billions of dollars annually. NIST is collaborating with US private flow laboratories to quickly reduce flow uncertainties to 0.3 % relative to the SI and ultimately to better than 0.1 %.

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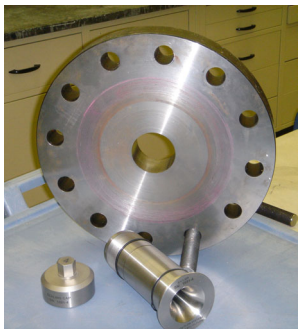
NIST is establishing a chain of traceability from its primary flow standards to the secondary standards at the cooperating laboratories by using critical flow venturis (CFVs) as transfer standards. CFVs have a well understood physics, simple geometric design, straightforward application, excellent long-term reproducibility, and are frequently used as transfer standards in international comparisons between various Natural Metrology Institutes (NMIs). We have calibrated small CFVs on the NIST site using low-pressure air. Using carefully designed measurements and reference data, we are extending the calibrations to large flows of high-pressure natural gas with only a small increase in uncertainty. The large-flow measurements are being conducted on the sites of cooperating laboratories that will use them to calibrate their own flow standards (*e.g.*, turbine meters). When this project is completed, the uncertainty of flow calibrations will be reduced, and they will be accepted internationally.

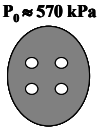
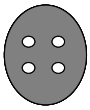
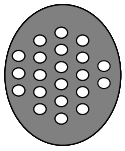
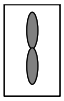
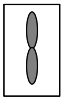
Four CFVs have been calibrated at NIST with an uncertainty of 0.14 %. These CFVs are being compared with flow standards traceable to NMIs in Germany and France. Steps have been taken to reduce the NIST uncertainty to 0.08 %, initially at low flows, and ultimately at higher flows. The next round of testing, whereby the air based CFV calibrations are transferred to natural gas, is underway and should be completed next year.



Critical Flow Venturi (CFV) calibrated at NIST

By 2007, NIST will have flow standards for high-pressure natural gas that are recognized internationally and are accessible to US industry for meter calibration.

CFV Traceability Chain

Stage	Standard	Reference Meter
1	NIST 26 m^3 *PVTt* 	Low Pressure CFV $P_0 \approx 570$ kPa 
2	Low Pressure CVF Bank $P_0 \approx 570$ kPa 	Medium Pressure CFV, 4x P_0 (upstream of LP CVF Bank) 
3	Medium Pressure CVF Bank 4x P_0 	High Pressure CFV, 16x P_0 (upstream of MP CVF Bank) 
4	High Pressure CVF Bank $P_0 \approx 7300$ kPa 	Turbine Meter Standard $P \approx 7300$ kPa (upstream of HP CVF bank) 
5	Turbine Meter Standards Array $P \approx 7300$ kPa 	Customer's Meter Under Test $P \approx 7300$ kPa, Downstream of Turbine Meter Standard MUT

References:

ISO 9300:1990 (E), ***"Measurement of Gas Flow by Means of Critical Flow Venturi Nozzles,"*** ISO/TC 30, Measurement of Fluid Flow in Closed Conduits.

A.N. Johnson and T. Kegel, ***"Uncertainty and Traceability for the CEESI Iowa Natural Gas Facility,"*** Journal of Research of the National Institute of Standards and Technology, 109, 345-369 (2004).